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NONNUCLEAR CRUISE MISSILES: POTENTIAL IN THEATER WARFARE

Volume 1-Executive Summary

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CONFLICT ENVIRONMENTS IN WHICH A CONVENTIONALLY ARMED CRUISE MISSILE COULD BE USED ARE OUTLINED; OPTIONS FOR DEPLOYMENT OF A SEA-GOING CRUISE MISSILE FORCE ON SUBMARINES AND SURFACE/AIRBORNE PLATFORMS ARE DISCUSSED; SELECTED LAUNCHER LEVELS ARE PROJECTED TO THE YEAR 2000. A DESCRIPTION OF THE TOMAHAWK SYSTEM TOGETHER WITH SYSTEM/SUBSYSTEM GROWTH OPTIONS IS PROVIDED. RECOMMENDATIONS ARE MADE CONCERNING PROGRAM PLANS FOR CONVENTIONALLY ARMED CRUISE MISSILE SYSTEMS.

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BACKGROUND

The advent of modern technologies in guidance, propulsion, and conventional munitions has already been manifested on the contemporary battlefield in the use of precision-guided antiarmor munitions and advanced field army air defenses. The planned deployment of nuclear-armed cruise missiles in U.S. theater nuclear and strategic forces evidences the broad applicability of these new technologies.

The same and related technologies show promise in meeting another set of military requirements: striking with accuracy and effect deep across the battle zone to interdict enemy forces in rear areas. Interdiction and deep strike operations have hitherto relied on increasingly vulnerable manned aircraft with either nuclear or conventional weapons, and on nuclear-armed missile systems. The emergent developments in guidance, propulsion, and enhanced penetrativity foreshadow unmanned aerodynamic vehicles with long range, low detectability, and accurate navigation capable of delivering substantial munition payloads.

Modern conventional munitions, coupled with accurate and timely delivery, can achieve in many cases the same or equivalent results in target destruction, disruption, or suppression as nuclear systems now deployed. This is not to say that the military effects of modern conventional weapons and nuclear weapons--much less the consequences of their use--can be considered equal or even equivalent. What can be said is that modern conventional weapon technology may be able to achieve the same military *results* as existing nuclear weapon technology.

This prospect is of enormous consequence across the spectrum of national security policy concerns, from military force and weapon planning through intelligence support, foreign policy formulation, and arms control. Although lacking the shock effect of nuclear weapons, conventional weapons have the advantage of:

- The absence of specific strictures against timely use which could raise the nuclear threshold.
- The removal or at least relaxation of politically dictated selectivity of employment.

- The elimination of delivery constraints that limit effectiveness to minimize collateral damage to friendly forces and noncombatants.

The field of modern, nonnuclear weaponry is a broad one, replete with research and engineering opportunities. This paper addresses the conventionally armed land-attack cruise missile as an example of a system that can complement or substitute for existing nuclear and conventional systems. The paper particularly emphasizes sea-launched cruise missiles for land attack. The analysis is more broadly focused, however, and also considers cruise missiles for ground attack as a family of weapons adaptable to a variety of launchers, forces, and missions.

Section 1 of the basic report 5384-2 presents a typology of conflict environments in which nonnuclear land-attack cruise missiles might be employed by U.S. sea-based forces in situations involving major or minor hostile powers. Section 2 briefly describes the types of targets and the general types of munitions available for cruise missiles. Section 3 examines present and future cruise missile forces by describing the baseline Tomahawk missile system and discussing planned and potential variations for different launch environments. This section describes the evolving force structure with which cruise missiles might be deployed at sea. Section 4 discusses the future of technological growth in cruise missiles and Section 5 presents an evolutionary program plan for cruise missile development.

CONCLUSIONS

- Cruise missiles using modern guidance, propulsion, and conventional munition technology can successfully attack important targets, including both defensive systems and other high priority targets. They can be employed either independently or in conjunction with other forces, such as manned strike aircraft. In operations in high-threat areas, submarine-launched cruise missiles may be required to suppress defenses so that manned aircraft and surface ship launched cruise missiles can deliver the necessary weight of ordnance against fixed and mobile targets (aircraft for strikes against dynamic targets and surface ships for high volume cruise missile launch).

- The first generation of conventionally armed cruise missiles--represented by Tomahawk technology and design--would be able to employ submunitions against selected fixed targets. The capability to deliver unitary warheads with the required accuracy is subject to significant uncertainties because of the more stringent delivery conditions with an impacting weapon. And uncertainties in current calculations of lethality and effectiveness for both submunitions and unitary warheads contribute to analytical uncertainty about specific weapon effects on particular targets.
- Sea-going launch platforms, both submarines and surface ships, are prime candidates for early deployment of the cruise missile for land attack. Considerable launcher capacity would be available as a result of current shipbuilding plans, and the weapon could be widely distributed within the fleet if procured in large numbers.
- The enhancement of carrier air power by deployment of an air-launched land-attack version would be much less significant because of limited system range and payload. However, carrier aircraft *do* need a standoff weapon against modern defended targets. Therefore, the carrier air version of the cruise missile is of value when the range of the aircraft is considered.
- The analyses conducted to date favor use of the cruise missile on sea-going platforms for campaigns against enemy naval shore facilities and other fixed target arrays. The major uncertainty is the balance between effectiveness and survivability of the launch platforms when operating within range of enemy forces. However, it is clear that the standoff range of the cruise missile would provide the launching platform more survivability with similar effectiveness when compared to the current Navy force structure and weapon systems.
- Naval cruise missile operations supporting the land campaign would differ significantly from a preplanned campaign against fixed facilities, and require further analysis.

- Cruise missiles deployed on land-based aircraft or ground-launchers are also attractive options providing they can be placed within striking range without undue vulnerability, as demonstrated by previous studies.
- Full realization of the cruise missile's potential will depend on the course of research and development efforts and the selection of deployment options.
- Considerable increase in munition-carrying capacity and range could be realized with a somewhat larger vehicle. The capacity of launchers currently envisioned for submarines and surface ships, and capacity limits on carrier aviation and some land-based aircraft, restrict missile growth to subsystem improvement and incremental growth in range and payload however. The larger vehicle could be deployed with other tactical (and strategic) aircraft and on ground launchers. Growth options to accommodate a larger vehicle could be developed for the sea-going platforms.
- Two subsystems appear to require particular attention in cruise missile development:
  1. Munitions and dispensing techniques tailored to cruise missile applications.
  2. An alternative or supplementary navigation and guidance system to insure flexible, worldwide operational capability.

RECOMMENDATIONS

1. The first-generation Tomahawk cruise missile should be deployed with naval surface and submarine forces, with the primary emphasis on surface forces because of their greater firepower potential.
2. Submarines of existing or new designs should be equipped with dedicated cruise missile launchers to exploit the unique attributes of subsurface forces.
3. Land-attack cruise missiles for carrier aviation should be deployed, but as a second priority to submarine and surface ship versions.

4. A variant of the Tomahawk should be considered for deployment with land-based tactical and strategic air to provide operational and planning experience.
5. Improvements to the current Tomahawk family should be pursued with the goal of making major block changes in the weapons deployed with various force elements.
6. In parallel, development of a second-generation land-attack cruise missile with increased payload and range capabilities should be initiated in concert with NATO.
7. Critical performance categories or parameters to be studied and improved in both Tomahawk and the second-generation system are:

   - Munitions and dispensing techniques tailored for cruise missile applications, including definition and empirical substantiation of lethality and effectiveness. A central authority for ordnance development is needed.
   - Navigation and guidance improvements, specifically the Global Positioning System (GPS) for global capability, and terminal homing for accurate delivery of specialized unitary warheads.
   - Range extension, especially for sea-going and ground-based launchers to enhance targeting flexibility and platform survivability.
   - Cruise missile survivability through analysis, simulation, and testing.
   - Possibilities for active and passive defense measures by target installations and forces.
   - Unit cost reduction, through both substitution of lower-cost subsystems and high-rate production of large quantities to achieve economies of scale.

8. The second-generation system should be deployed with land-based air and on-ground launchers.

9. Launcher design and installation on sea-going platforms should allow for modification to accommodate a second-generation naval land-attack cruise missile.
10. The mission planning cycle should be designed to exploit future possibilities for attacking mobile or moveable targets. Development of sensors and munitions (and dispensers) for this class of target should be pursued.
11. Scenarios and campaign analyses for employment of naval land-attack cruise missiles should be further examined, particularly support of the land battle and utilization in third-world crises.
12. Future analyses of cruise missile capabilities should include parallel or complementary developments in other force elements, such as ballistic systems, battlefield systems, tactical aircraft, and command, control, communications, and intelligence.

DISCUSSION

The analysis of weapon characteristics and force structure and capabilities in the near term starts with the AGM/BGM-109 family of weapon designs known as the Tomahawk. The family includes two nuclear members, the BGM-109A submarine-launched weapon and the BGM-109G ground-launched missile. Conventionally armed versions have been designed for launch from submarines, surface ships, Navy carrier aviation, and U.S. Air Force tactical and strategic combat aircraft. The inherent versatility of the system makes it readily adaptable to other modes, such as transport aircraft and fixed or mobile ground launchers. Options for both unitary warheads and submunitions are constrained only by payload weight limits and volume available.

The report outlines the conflict environments in which a conventionally armed cruise missile might be used; discusses the options for deployment of a sea-going force on submarine, surface, and airborne platforms; and projects selected launcher levels to the year 2000. It describes the basic Tomahawk and derivatives, reviews system and

subsystem growth options, and recommends an evolutionary program plan for conventionally armed, long-range cruise missile systems.*

The potential opponents against which U.S. forces might employ conventionally armed cruise missiles can be divided into major and minor adversaries. Cruise missiles could be used against a major adversary either independently in a single strike or in an extended campaign against an integrated target structure (such as the base areas and facilities of the enemy's fleet), or in coordinated support of forces engaged in the land campaign.

In operations against an integrated target structure, cruise missiles would be employed to suppress defenses (missile and radar sites and interceptor bases) and to protect U.S. naval operating forces by attacking enemy force elements such as long-range maritime strike aircraft and their munition storage, assembly, and checkout facilities. In the offensive strike, carrier aviation would carry the main weight of ordnance once the defenses were disrupted or destroyed. This use of sea-based forces has been extensively analyzed; the major unresolved operational issue is balancing strike effectiveness against survivability of surface forces launching the strike. The primary factors in play are the effective range of the strike weapons compared to the reach of enemy forces, and the capabilities of these enemy forces against weapons protecting the U.S. naval forces. It is clear that standoff cruise missiles will improve this balance over the current force structure and weapon systems. The major unresolved technical issue is the effectiveness of available munitions, particularly unitary warheads.

The second conflict environment category--naval support of the land campaign--would differ significantly from the first in the uncertainty

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* The report does not treat in any detail other advanced nonnuclear systems for ship and submarine attack, or air-delivered free-fall, short-range, or unpowered weapons. In some cases munition, dispensing, and guidance components of these systems may be adapted for use in development programs for long-range, nonnuclear ground-attack missiles. But the differing requirements in, for example, the antiship and land-attack missions will always put a practical limit on the commonality of systems obtainable and the possibilities for the transference of technology between systems.

of campaign duration; the preponderance of mobile rather than fixed targets; the different munition requirements; the compression of the strike planning cycle to follow the changing course of the conflict; and the requirement for close coordination with land-based operating forces. It seems reasonable that cruise missiles could best support the land campaign by being targeted against critical "nodes" such as logistic and command centers. Support of the land campaign has not been analyzed in sufficient depth to define all of its special requirements, although analyses of ground-based systems provide some insight into the target structure and force requirements for a sea-based system.

Analyses of both these conflict categories assume either a conventional war or at least a conventional phase of conflict. The initiation of nuclear operations would have two principal effects on cruise missile utilization: nuclear weapon employment against certain target categories could release conventional cruise missile assets for other targets, but a nuclear environment could also severely increase the risk to the naval forces engaged in land attack. It is important to note that "soft" nuclear launching sites or nuclear weapon storage sites could be attacked with reasonable success by conventionally armed cruise missiles.

A final major opponent scenario involves using the cruise missile's penetrativity, accuracy, and tailored munitions in a punitive strike short of war. On balance, this kind of operation is more likely to be applicable to a conflict with a less-formidable foe--here termed a minor opponent.*

In confrontation, crisis, or conflict with a minor opponent, limited military operations such as punitive strikes or strikes supporting sanctions such as naval blockades are a real possibility. Whether cruise missiles would be the weapon of choice depends on the particular situation, but three operational attributes might particularly recommend them in a limited strike:

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* A minor opponent differs from a major one in not having a full range of modern forces to support global interests. Some minor opponents would have strong capabilities in selected categories (such as air defense) within their local area or region.

- Because cruise missiles are unmanned, the risk of U.S. casualties (including captives, with the bargaining power they confer on the hostile state) is minimized.
- The wide variety of launch modes envisioned, including the Navy's major surface combatants and the Air Force's strategic aircraft, makes cruise missile firepower widely available.
- In particular, the option for submarine launch enables both surprise attacks and covert strikes.

Punitive strikes and blockade support are likely to be short term. Continuing involvement in operations, including conflict, might occur when forces are interposed between potentially warring forces; intervening on one side or another in a conflict (including opposing the intervention of a third power); supporting actual invasion by U.S. forces; and combating a full-fledged invasion by another state. In these kinds of conflicts, cruise missiles offer the potential of flexible, long-range firepower without the extensive basing structure needed for forces such as land-based tactical aviation. The particular nature of each individual situation would dictate the size and composition of forces (including missiles) most likely to achieve U.S. objectives.

The final conflict environment category considered is direct conflict with a major power in an area remote from either homeland. This situation could be increasingly likely in coming years as the global interests of states such as the Soviet Union expand. Here, the ability of one side or the other to bring decisive force to bear from immediately available resources before large-scale reinforcement and supply operations can begin for the other side may be instrumental both in concluding the localized conflict and avoiding escalation. Land-attack cruise missiles widely deployed in naval units routinely assigned to distant areas could confer a signal advantage on the United States in such cases.

Whatever the conflict environment, the effective utilization of cruise missile forces will depend on the following factors:

- The operational characteristics of the missile system.
- The availability of munitions matched to the weapon system as well as to targets of interest.
- Deployment and employment options afforded by the launcher and missile types and complements procured.
- Worldwide command and control and targeting capabilities and flexibility.

Growth potential in each of these areas must be examined to decide whether an initial cruise missile force would be only a short-lived, stop-gap measure or the foundation for long-term improvement in military capabilities.

The targets of interest for a cruise missile force can be categorized as:

- Point targets, such as specific structures or items of equipment.
- Area targets, both collections of individual, small targets and very large structures.
- Point-in-area targets, including key elements of large structures or key components of an installation.

The targets falling in these categories can also be described in other ways--by function (tactical aviation, air defense, logistics, surveillance), by relative vulnerability (soft, hard), and by mobility (fixed, mobile, transportable)--all of these target characteristics impact on targeting strategies.

Arrayed against these targets would be unitary warheads, including those with special penetration characteristics; and submunitions, both unguided (and hence dispensed in patterns to blanket an area) and those guided by integral seekers to individual targets. A large number of candidate munitions are in the inventory, under development, or in concept. With a very few exceptions, however, none of these munitions was designed primarily for cruise missile delivery. An authority should be designated or established to plan and coordinate the development

and testing of munitions for cruise missiles and, equally important, the development of dispensing techniques and systems. Such a munition authority would also derive consistent nonnuclear vulnerability data for targets and develop a common set of utility measures for munition lethality and effectiveness.

The report considers proposals for equipping submarines and surface ships with conventionally armed cruise missiles--the most developed of the deployment options--in some detail. The Tomahawk land-attack cruise missile is designed for launch from standard submarine torpedo tubes, but the limited ordnance-carrying capacity of attack submarines and the variety of requirements already placed on this prime resource make it unlikely that present submarines could make a substantial contribution to cruise missile campaigns (except for specialized strike missions).

The report summarizes and assesses alternative proposals which have been made for increasing submarine firepower: backfitting older Polaris ballistic missile submarines; modifying current Los Angeles-class attack submarines and redesigning future units; and designing new classes of dedicated cruise missile submarines or multi-mission attack submarines, either nuclear-powered or diesel-electric. Conventionally powered designs appear to offer the lowest life-cycle cost but lack the strategic mobility of nuclear units with their capabilities for long-distance, high-speed, submerged transit. Additional analysis is needed to assess fully the tradeoffs between capabilities and cost in meeting force requirements. The programs described in the report range in size from a couple of hundred to a few thousand dedicated launchers.

In contrast, plans and prospects for naval surface units could produce a total complement of some 10,000 multipurpose launchers of the new vertical launch system (VLS). Not all VLS launchers would be available for land-attack cruise missiles because they will also be utilized for missiles for antisubmarine warfare, antisurface warfare, and fleet anti-air warfare. If, as currently envisioned, the VLS is installed on the Navy's most modern surface combatants (either as original equipment

or backfitted in units already built), the potential will be created for strike warfare from a large number of ships deployed with all fleet elements. This would diminish the current overdependence on aircraft carriers for land-attack operations. Indeed, relatively small task groups, such as the Middle East Force in the Persian Gulf or the occasional Taiwan Straits patrol, could be invested with a politically significant capability to project force hundreds of miles inland on short notice.

The report describes shipbuilding programs and plans for the CG-47, DD-963 and -993, and the DDG-X to project force buildup rates for VLS. It presents possible missile mixes for individual units and for task forces in different mission environments.

The impressive firepower possibilities of the cruise missile installed in VLS on surface ships and in submarines are clear. The competing demands of other naval weapons compatible with the VLS have led to suggestions for alternative sea-going launch platforms for land-attack firepower, including refurbished battleships and commercial ships. The VLS has, however, great flexibility in that each ship can be loaded with missiles tailored for a mission; i.e., in practice a ship could be heavily loaded with land-attack cruise missiles for a strike mission.

The other deployment options under active consideration are Tomahawk variants for naval carrier aviation and for air force tactical aircraft. These systems are collectively called the joint medium-range air-to-surface missile (JMRASM). Both air-launched versions will be limited in size by the restrictions imposed by aircraft operating requirements and, in the Navy's case, by ordnance handling facilities on carriers. Limitations imposed on the Navy JMRASM will restrict its capabilities such that priority should go first toward ship- and submarine-launched cruise missile forces. The U.S. Air Force JMRASM will not be quite as limited, and could serve as the foundation for future growth and development.

The final deployment option is ground launchers, either fixed or mobile. This approach has received more analytical attention than any of the others, but is not now being actively developed. Development and deployment of the nuclear-armed ground-launched cruise missile as

part of NATO's theater nuclear forces may provide useful insights into the technical and operational deployment aspects of a conventionally armed, ground-launched system. However, the special political, operational, and security concerns that attend nuclear systems will likely constrain its deployment and operating pattern to one quite different than would be applicable to a nonnuclear system, and characteristics could not be directly transferred.

The report emphasizes the technological opportunities for growth and development of cruise missile systems. It describes an evolutionary program plan starting with the Tomahawk weapon system. The potential improvements to Tomahawk outlined in the report should be incorporated through major block changes.

A change in basic system design may be required, however, to realize fully the potential inherent in the cruise missile weapon. This report therefore advocates that a parallel program be initiated with the objective of exploiting available technology to design a second-generation system with more effectiveness and reduced unit cost. This growth version would not attempt to sacrifice survivability, and could have the option of incorporating passive or active defensive measures.

The size and weight of the proposed second-generation system might restrict its deployment to land-based systems, including tactical and strategic aircraft and ground launchers which could eliminate the flexibility and mobility gained from sea launched cruise missile forces. Larger U.S. Air Force aircraft such as the F-111 could possibly launch the missile (perhaps also the NATO Tornado aircraft). The adaptability to first-line NATO aircraft and the suitability for deployment on ground launchers open the way to Allied participation in missile design, development, and procurement. Indeed, such NATO involvement may be necessary to insure that conventionally armed cruise missile forces are distributed across the breadth of the potential battle zone in Europe. This could be advantageous even though the survivability of such forces would likely be less than sea-based cruise missile forces.

If the second-generation system were determined to be a large missile, it perhaps could not be launched from existing submarine torpedo

tubes, the VLS as now designed, carrier aviation operating under current flight rules, or small land-based tactical aircraft. Maintaining a capability to launch land-attack cruise missiles from currently planned seagoing platforms would be desirable because of force survivability and also because of the value of cruise missiles in attacking naval targets ashore that present a threat to U.S./NATO naval forces (as previously noted). If a second generation cruise missile had to be bigger for the land campaign or naval support role, it would require modifying the launch system. Accepting the inherent limitation of the current airframe size seems to limit growth to subsystem improvement and substitution; however, technology and mission considerations are important in determining the characteristics of a second generation cruise missile.

An option would be to maintain separate programs for naval land-attack cruise missiles and a larger cruise missile for ground or bomber launch. If it were desirable to launch a larger cruise missile from sea platforms, growth could occur in subsurface launch platforms by adding vertical tubes distinct from torpedo tubes. On surface ships, the VLS could be restructured to accept a fixed number of land-attack missiles larger than the other missile systems carried. A better option is probably to carry a certain number of larger land-attack missiles in a new launcher, leaving the VLS to accommodate a number of other missiles interchangeably.

The technological opportunities for a Block II Tomahawk, a second-generation system for the late 1980s, and a possible third-generation system for the 1990s are discussed in detail in Sections 4 and 5 of the basic report.

The final dimension of an effective cruise missile force is worldwide command and control and targeting capabilities and flexibility. Section 3 and Appendix A describe the probable mission planning process for a conventionally armed cruise missile force. The major findings fall in two areas.

First, because of the unique navigation and guidance scheme utilized by the current generation of cruise missiles, the need exists for a worldwide, interactive structure to collect and process reference

data for navigation and guidance (preferably in a fleet wide GEOREF system), prepare specific mission plans, and exchange data among different echelons of command and launching platforms in different geographical areas. Without such a system, force effectiveness will be difficult to maintain during periods of crisis.

Secondly, even with this system the potential requirements for data collection and processing are likely to outstrip available resources for the foreseeable future, especially considering the rich potential for crises in remote areas of the world. To permit worldwide operations (as well as operations in any areas where navigation and guidance by terrain contour or digital scene matching may not be possible), an alternative or complementary navigation and guidance system for updating the inertial system should be considered. The most practical, near-term possibility appears to be the GPS, for which the initial satellites are now being tested. Full system capability is planned for 1987. GPS may not be suitable for long term general war involving strategic systems because both the ground station and the space segment are potentially vulnerable, but these considerations would not apply in a lesser conflict or a conflict with a minor power. However, in a short term general war, information received from the system before it could be attacked would be invaluable in delivering initial strikes which could be decisive and prevent a longer war.

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Charleston Naval Shipyard
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Cruiser Destroyer Group One
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Joint Cruise Missiles Project Ofc
Department of the Navy
ATTN: JCMG-707

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ATTN: DCS (P&O), Requirements Div
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Naval Air Systems Command
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Naval Intelligence Support Ctr
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Naval Research Laboratory
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Naval Sea Systems Command
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ATTN: SEA-06H2
2 cy ATTN: SEA-6431G, H. Seguine

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ATTN: Commanding Officer

Naval Submarine School
ATTN: Commanding Officer

Naval Surface Force, Atlantic
ATTN: Commander

Naval Surface Force, Pacific
ATTN: Commander

Naval Surface Weapons Center
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ATTN: Code E-11, Tech Service

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Naval Weapons Center
ATTN: Code 32607, L. Thompson

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ATTN: G. Binns

Navy Field Operational Intelligence Office
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Newport Laboratory
Naval Underwater Systems Center
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Department of the Navy
ATTN: Nuclear Warfare Department

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Department of the Navy
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ATTN: Code N-3
3 cy ATTN: Code N-2

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Department of the Navy
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U.S. Naval Air Forces
Atlantic Fleet
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U.S. Submarine Force
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Air Force Systems Command
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Studies & Analyses
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Department of the Air Force
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Department of the Air Force
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Tactical Air Command
Department of the Air Force
ATTN: TAC/DO

Tactical Air Command
Department of the Air Force
ATTN: TAC/DR

Tactical Air Command
Department of the Air Force
ATTN: TAC/INO

Tactical Air Command
Department of the Air Force
ATTN: TAC/SMO-G

Tactical Air Command
Department of the Air Force
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Tactical Air Command
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Commander-in-Chief
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DEPARTMENT OF THE AIR FORCE (Continued)

U.S. Air Forces in Europe
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ATTN: Asst Dir for Rsch, J. Buchanon
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U.S. Arms Control & Disarmament Agcy
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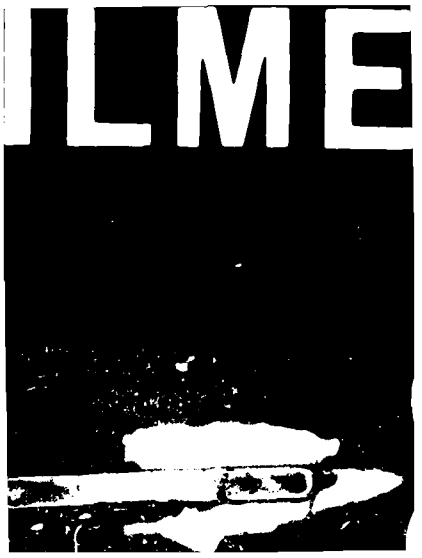
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